REDUCING GREENHOUSE GAS EMISSIONS IN AGRICULTURE: Policy framework and implementation in Vietnam

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Climate change (CC) is posing major challenges to Vietnam's agricultural production, especially in the Mekong Delta - the country's largest rice granary. According to the 2020 greenhouse gas (GHG) inventory data calculated by the Institute of Agricultural Environment, Vietnam's total GHG emissions reached about 454.6 million tons of CO_2 eq, nearly double that of 2010. Of which, agriculture contributed about 116.51 million tons, with crop cultivation alone accounting for 80% of the industry's emissions [9].

Among crop types, rice cultivation is the largest source of greenhouse gas (GHG) emissions, currently accounting for 50.31% of total agricultural GHG emissions and over 75% of the sector's methane (CH_4) emissions [1]. The characteristics of paddy rice cultivation where fields are continuously flooded create anaerobic conditions that facilitate the decomposition of organic matter and the release of CH_4. Methane alone constitutes 46% of the total GHG emissions from rice production, while excessive use of chemical fertilizers further contributes to nitrous oxide (N_2O) emissions. According to the IPCC (2014), 1 kg of CH_4 has a global warming potential equivalent to 28 kg of CO_2eq, and 1 kg of N_2O is equivalent to 256 kg of CO_2eq [3]. It is estimated that rice production in Viet Nam emits nearly 50 million tons of CO_2eq per year, meaning that on average, every 0.9 ton of rice produced is associated with 1 ton of CO_2eq.

Not only cultivation practices but also post-harvest losses contribute to emissions, accounting for over 10% of total emissions from life-cycle of rice production. In addition, post-harvest straw management remains a major challenge: in the Mekong Delta alone, approximately 50 million tons of rice straw are generated annually, of which over 50% are still burned in the field and around 30% are incorporated into flooded paddies - both practices that significantly increase GHG emissions [4].

Without effective interventions, it is forecast that by 2030, total national emissions could nearly double, reaching about 990.15 million tons of CO_2 eq. These figures show that reducing emissions in crop production, especially in the rice sector, is an urgent requirement to both respond to climate change and improve the competitiveness of Vietnamese agricultural products in the international market.

POLICY ORIENTATION IN THE NEW CONTEXT

In the process of implementing the commitment to reduce net emissions to zero by 2050, the Vietnamese Government has gradually improved the policy system to orient agricultural production in general and crop cultivation in particular towards low emissions. An important milestone is Decision No. 300/QD-TTg dated March 28, 2023 approving the Project on transforming Vietnam's food system towards transparency - responsibility - sustainability for the period 2023-2030, with a vision to 2045 (Decision No. 300/QD-TTg) [6]. The issuance of Decision No. 300/QD-TTg affirms that reducing GHG emissions is a pillar in transforming the food system, requiring the promotion of climate-smart agricultural production, the development of low-emission value chains, the development of agricultural carbon credits and the integration of emission reduction targets into the entire product life cycle, from production to consumption. This is a systematic orientation, serving as a strategic framework for specific industry policies.

Subsequently, the Prime Minister approved the Project on One Million Hectares of High-Quality, Low-Emission Rice in the Mekong Delta under Decision No. 1490/QĐ-TTg dated November 27, 2023 [7]. This flagship policy aims to operationalize the orientation set out in Decision No. 300, contributing both to reducing greenhouse gas (GHG) emissions in rice production, the sector with the highest emission levels and to enhancing the value and international competitiveness of Vietnamese rice. The project has entered its implementation phase, introducing measures such as alternate wetting and drying (AWD) irrigation, the use of low-emission fertilizers, circular management of rice straw, the development of Measurement, Reporting, and Verification (MRV) systems, and pilot testing of carbon credit mechanisms in agriculture.

Currently, the Ministry of Agriculture and Environment is developing a Low Emission Crop Production Project for the period 2025–2030. Although still in the draft stage, this project has initially identified the target of applying emission reduction measures on a minimum area of 2.5 million hectares, reducing about 30% of CH_4 emissions and at least 10% of total GHG emissions of the crop sector compared

to 2020. Along with that, the Project also aims to build an emission database to serve the MRV system, organize training and communication to change farming practices, and develop low-emission agricultural product brands, thereby expanding opportunities to participate in international markets.

Thus, the policy process of the Government of Vietnam shows a consistency from the systemic strategic orientation to the specialized policies that have been implemented for the period 2025–2030 and vision toward 2045. The coherence across these policy levels reflects Viet Nam's strong commitment to aligning emission reduction objectives with the national strategy for food system transformation, thereby contributing to sustainable development goals and the fulfillment of international climate commitments.

EMERGING ISSUES

Although policy directions have been clearly established, the implementation of low-emission crop production in Vietnam still faces multiple challenges.

First, in terms of institutions and policy, the system of legal documents supporting low-emission agricultural production remains fragmented, while the legal framework for an agricultural carbon market is still underdeveloped. In particular, the Measurement, Reporting, and Verification (MRV) system for emission reductions has not yet been fully operated. Current low-emission farming initiatives are mostly small-scale and project-based, lacking system-wide coordination. Moreover, emission measurement tools have not been standardized, making it difficult for emission reduction results to be officially recognized and participate in international carbon markets. In addition, incentive mechanisms for farmers and enterprises remain insufficient to drive large-scale transformation, while green credit policies and financial support schemes are still at the pilot stage.

In terms of technical and technological perspective, numerous studies have demonstrated the effectiveness of

People in Bien Bach commune (Ca Mau) practice rice-shrimp rotation (intercropping rice and giant river prawn) to create a low-emission value chain

emission-reduction practices. Thuan et al. (2022) showed that the Alternate Wetting and Drying (AWD) irrigation method could reduce CH_4 emissions by up to 51% compared to conventional cultivation in the Mekong Delta [8]. Similarly, research by the Vietnam Academy of Agricultural Sciences (VAAS) on climate-smart agriculture models in Quang Nam province revealed significant emission reductions and improved water use efficiency [2]. However, scaling up these models remains challenging due to high initial investment costs, inadequate irrigation infrastructure, and the persistence of traditional farming practices.

In terms of market and finance, one of the major obstacles is that a mechanism for commercializing carbon credits in agriculture has not yet been established. Therefore, emission reduction activities have not yet brought direct economic benefits to farmers and cooperatives. Loan et al. (2024) when studying the organic rice model following the circular agriculture direction pointed out that although it reduces emissions and has environmental benefits, this model faces difficulties in output and consumption markets, limiting the ability to replicate [5]. This makes the short-term benefits of farmers not guaranteed, affecting the motivation for conversion.

There are still many shortcomings in the organization of agricultural production. Most of the cultivated area is still managed by small-scale farmers, leading to difficulties in synchronously applying technical solutions and monitoring emissions. The awareness of local people and officials about low-emission production is limited, while the role of cooperatives and agricultural enterprises has not been fully promoted to lead the value chain. The lack of connection between actors in production, processing and consumption reduces the effectiveness of policy implementation, while limiting the ability to build low-emission agricultural product brands at the national scale.

The above issues show a significant gap between policy orientation and implementation practice. Without a comprehensive solution to remove bottlenecks in institutions, techniques, finance and production organization, the target of reducing emissions in

crop production by 2030 will be difficult to achieve as expected, and the opportunity to improve the position of Vietnamese agricultural products in the international market will not be fully exploited.

PROPOSED SOLUTIONS AND POLICY MECHANISMS

From the Government's strategic orientations and the current implementation situation with many limitations, it can be seen that the goal of reducing emissions in crop production in Vietnam can only be achieved when simultaneously removing institutional, technical, financial and production organization bottlenecks. First of all, in terms of institutions, it is necessary to soon complete the legal framework for low-emission agricultural production, especially the construction and operation of the emission measurement, reporting and verification (MRV) system according to international standards. This is a prerequisite for the results of emission reduction in agriculture to be recognized and be able to participate in the carbon credit market. Along with that, incentive policies need to strongly shift from short-term support to long-term mechanisms, ensuring benefits for farmers and businesses when investing in low-emission production.

Along with institutions, technical and technological solutions play a key role. Vietnam needs to promote research, improve and replicate water-saving and emission-reducing farming models such as alternate wetting and drying or improved rice intensification systems. Integrating digital technology, artificial intelligence and environmental sensors into field management will help optimize the use of water, fertilizers and pesticides, thereby reducing emissions and increasing productivity. However, for technical solutions to be widely applied, there needs to be a synchronous infrastructure investment policy, especially irrigation and mechanization, accompanied by training and coaching activities to change traditional farming practices of farmers.

In terms of market and finance, it is necessary to form a clear and sustainable green finance mechanism. Specifically, it is necessary to design preferential credit packages and conversion support funds for farmers, cooperatives and agricultural enterprises when participating in low-emission production. At the same time, the State needs to create a legal corridor to commercialize carbon credits in the agricultural sector, connecting with the international carbon market. When economic benefits are guaranteed, farmers and enterprises will have stronger motivation to maintain and expand emission-reducing farming models.

Finally, in terms of production organization, it is necessary to continue to accelerate restructuring towards value chain linkages, promoting the role of cooperatives and agricultural enterprises in leading production, consumption and building low-emission agricultural product brands. Through linkage chains, farmers not only have access to technology and capital, but are also guaranteed stable output, thereby increasing confidence and willingness to participate in the transformation process.

The above solutions, if implemented in a synchronous and cohesive manner, will create a solid foundation for Vietnam to realize its goal of reducing emissions in crop production. This is not only a requirement to respond to climate change, but also an opportunity to increase the value of agricultural products, increase competitive advantages and affirm the national commitment to the roadmap towards net zero emissions by 2050t■

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